

Test & Evaluation within the Acquisition Life Cycle

Test and Evaluation is a management tool and an integral part of the system development process. This module will address the policy structure and oversight mechanisms in place for test and evaluation. The following reading is derived from various documents within the acquisition community.

Objectives

1. Given the DoD system acquisition process, you should be able to identify the test and evaluation elements of the acquisition process.
2. Recognize the typical test and evaluation activities utilized throughout each stage of the acquisition process.

Importance of Test and Evaluation

The Test and Evaluation (T&E) process is an integral part of the Systems Engineering Process (SEP), which identified levels of performance and assists the developer in correcting deficiencies. It is a significant element in the decision-making process, providing data that support trade-off analysis, risk reduction, and requirements refinement. Program decisions on system performance maturity and readiness to advance to the next phase of development take into consideration demonstrated performance. The issue of paramount importance to the service member user is system performance, i.e., will it fulfill the mission. The T&E process provides data that tell the user how well the system is performing during development and if it is ready for fielding. The responsibility of decision-making authorities centers on assessing risk trade-offs. As states in Department of Defense Directive (DoDD) 5000.1, The Defense Acquisition System, "Test and evaluation shall be integrated throughout the defense acquisition process. Test and evaluation shall be structured to provide essential information to decision-makers, assess attainment of technical performance parameters, and determine whether systems are operationally effective, suitable, survivable, and safe for intended use. The conduct of test and evaluation, integrated with modeling and simulation, shall facilitate learning, assess technology maturity and interoperability, facilitate integration into fielded forces, and confirm performance against documented capability needs and adversary capabilities as described in the system threat assessment."¹

Testing as a Risk Management Tool

Correcting defects in weapons has been estimated to add from 10 percent to 30 percent to the cost of each item.² Such costly redesign and modification efforts can be reduced if carefully planned and executed T&E programs are used to detect and fix system deficiencies early in the acquisition process. Fixes instituted during early work efforts (Systems Integration (SI)) in the System Development and Demonstration (SDD) phase cost significantly less than those implemented after the Critical Design Review (CDR), when most design decisions have already been made.

T&E results figure prominently in the decisions reached at design and milestone reviews. However, the fact that T&E results are required at major decision points does not presuppose that T&E results must always be favorable. The final decision responsibility lies with the decision-maker who must examine the critical issues and weigh the facts. Only the decision-maker can determine the weight and importance that is to be attributed to a system's capabilities and shortcomings and the degree of risk that can be accepted. The decision-making authority will be unable to make this judgment without a solid base of information provided by T&E. Figure 7001-1 illustrates the Life Cycle Cost (LCC) of a system and how decisions impact program expenditures.

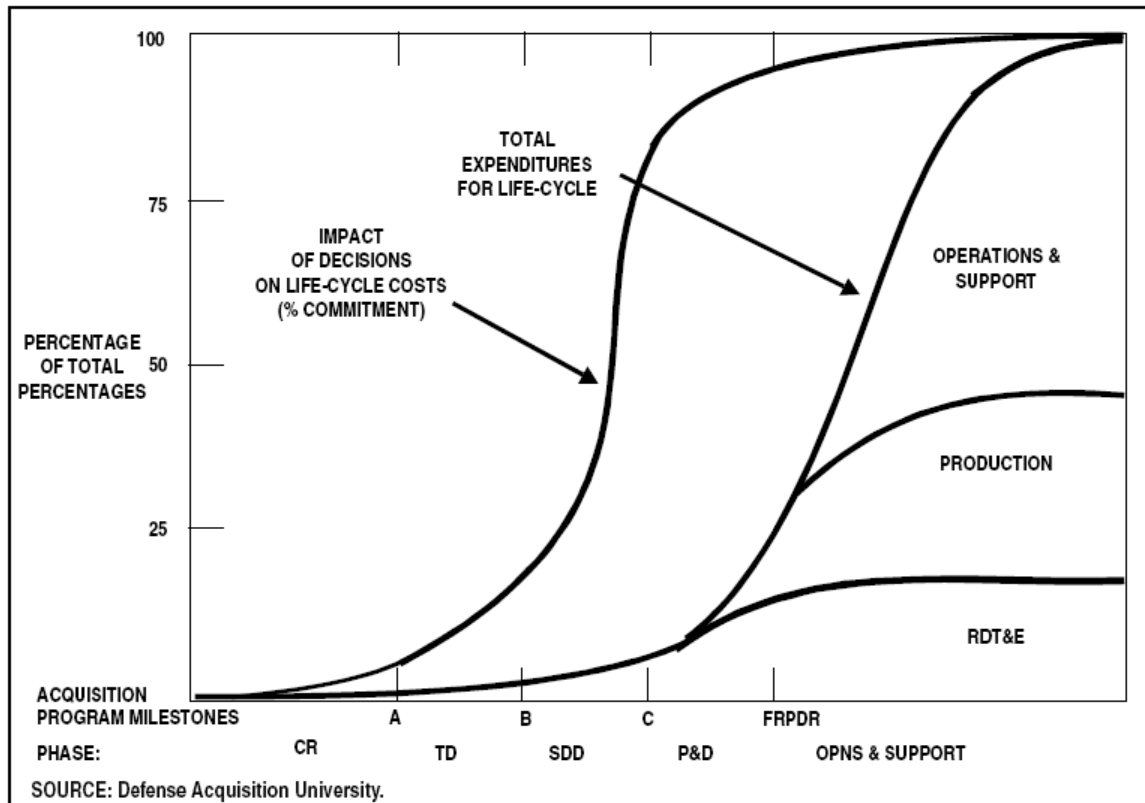


Figure 7001-1 Life Cycle Cost Decision Impact and Expenditures

A Defense Science Board (DSB) 1999 Task Force focused on a broad overview of the state of T&E within the Department of Defense (DoD)³. This group made the following observations about the T&E process:

- The focus of T&E should be on how to best support the acquisition process;
- T&E planning with Operational Test (OT) personnel should start early in the acquisition cycle;
- Distrust remains between the development and test communities;
- Contractor testing, developmental testing, and operational testing have some overlapping functions;
- Ensuring the test data are independently evaluated is the essential element, not the taking of the data itself;

- Responses to perceived test “failures” are often inappropriate and counterproductive.

The DSB Task Force (1983) developed a set of templates for use in establishing and maintaining low-risk programs. Each template described an area of risk and then specified technical methods for reducing that risk. PMs and test managers may wish to consult these templates for guidance in reducing the risks frequently associated with test programs. The DoD manual *Transition from Development to Production* contains sample risk management templates.⁴

The T&E Contribution at Major Milestones

T&E progress is monitored by the Office of the Secretary of Defense (OSD) throughout the acquisition process. Their oversight extends to Major Defense Acquisition Programs (MDAPs) or designated acquisitions. T&E and officials within OSD render independent assessments to the Defense Acquisition Board (DAB), the Defense Acquisition Executive (DAE), and the Secretary of Defense (SECDEF) at each system milestone review. These assessments are based on the following T&E information:

- The Test and Evaluation Master Plan (TEMP) and more detailed supporting documents developed by responsible Service activities;
- Service test agency reports and briefings;
- T&E, Modeling and Simulation (M&S), and data from other sources such as PMs, laboratories, industry developers, studies and analyses.

At Milestone B, the OSD T&E assessments reflect an evaluation of system concepts and technology alternatives using early performance parameter objectives and thresholds found in an approved preliminary TEMP. At Milestone C, assessments include an evaluation of previously executed test plans and test results. At the Full Rate Production Decision Review (FRPDR), assessments include consideration of the operational effectiveness and suitability evaluations of weapon systems.

A primary contribution made by T&E is the detection and reporting of deficiencies that may adversely impact the performance capability or availability/supportability of a system. A deficiency reporting process is used throughout the acquisition process to report, evaluate, and track system deficiencies and to provide the impetus for corrective actions that improve performance to desired levels.

T&E Contributions Prior to Milestone B

During Concept Refinement (CR) and Technology Development (TD) activities prior to Milestone B, laboratory testing and M&S are conducted by the contractors and the development agency to demonstrate and assess the capabilities of key subsystems and components. The test and simulation designs are based on the operational needs documented in the Initial Capabilities Document (ICD). Studies, analyses, simulation, and test data are used by the development agency to explore and evaluate alternative

concepts proposed to satisfy the user's needs. Also during this period, the Operational Test Agency (OTA) monitors CR and TD activities to gather information for future T&E planning and to provide effectiveness and suitability input desired by the PM. The OTA also conducts Early Operational Assessments (EOAs), as feasible, to assess the operational impact of candidate technical approaches and to assist in selecting preferred alternative system concepts.

The development agency prepares the Technology Development Strategy (TDS) with its early T&E strategy for Developmental Test and Evaluation (DT&E) and M&S. The TDS presents T&E plans for system design(s) and engineering and performance evaluations. The OTA may provide an EOA. This information is incorporated into the PM's TEMP that documents the program's T&E strategy that supports the Milestone B decision to proceed to the next phase.

T&E Contributions prior to Milestone C

During the SDD phase, concepts approved for prototyping form the baseline that is used for detailed test planning. The design is matured into an Engineering Development Model (EDM), which is tested in its intended environment prior to Milestone C.

In SI, the development agency conducts T&E to assist with engineering design, system development, risk identification, and to evaluate the contractor's ability to attain desired technical performance in system specifications and achieve program objectives. The DT&E includes T&E of components, subsystems, and prototype development models. T&E of functional capability, interoperability, and integration with fielded and developing equipment and systems is also included. During this phase of testing, adequate DT&E is accomplished to ensure engineering is reasonably complete (including survivability/vulnerability, compatibility, transportability, interoperability, reliability, maintainability, safety, human factors, and logistics supportability). Also, this phase confirms that all significant design problems have been identified and solutions to these problems are in hand.

The Operational Test and Evaluation (OT&E) agency should conduct an EOA for the Design Readiness Review (DRR) to estimate the system's potential to be operationally effective and suitable; identify needed modifications; and provide information on tactics, doctrine, organization, and personnel requirements. The early OT&E program is accomplished in an environment containing limited operational realism. Typical operational and support personnel are used to obtain early estimates of the user's capability to operate and maintain the system. Some of the most important products of user assessments of system maintainability and supportability are human factors and safety issues.

In Systems Demonstration, the objective is to design, fabricate, and test a preproduction system that closely approximates the final product. T&E activities of the EDM during this period yield much useful information. For example, data obtained during EDM T&E can be used to assist in evaluating the system's maintenance training

requirements and the proposed training program. Test results generated during EDM T&E also support the user in refining and updating employment doctrine and tactics.

During Systems Demonstration, T&E is conducted to satisfy the following objectives:

- As specified in program documents, assess the critical technical issues:
 - Determine how well the development contract specifications have been met;
 - Identify system technical deficiencies and focus on areas for corrective actions;
 - Determine whether the system is compatible, interoperable, and can be integrated with existing and planned equipment or systems;
 - Estimate the Reliability, Availability, and Maintainability (RAM) of the system after it is deployed;
 - Determine whether the system is safe and ready for Low Rate Initial Production (LRIP);
 - Evaluate effects on performance of any configuration changes caused by correcting deficiencies, modifications, or Product Improvements (PI);
 - Assess human factors and identify limiting factors.
- Assess the technical risk and evaluate the tradeoffs among specifications, operational requirements, LCCs, and schedules;
- Assess the survivability, vulnerability, and logistics supportability of the system;
- Verify the accuracy and completeness of the technical documentation developed to maintain and operate the weapons system;
- Gather information for training programs and technical training materials needed to support the weapon system;
- Provide information on environmental issues for use in preparing environmental impact assessments;
- Determine system performance limitations and safe operating parameters.

Thus, T&E activities intensify during this phase and make significant contributions to the overall acquisition decision process.

The development agency evaluates the results of T&E for review by the Service headquarters and the Service acquisition review council prior to system acquisition review by the Milestone Decision Authority (MDA). The evaluation includes the results of testing and supporting information, conclusions, and recommendations for further engineering development. At the same time, the OT&E agency prepares an Independent Operational Assessment (IOA), which contains estimates of the system's potential operational effectiveness and suitability. The Operational Assessment (OA) provides a permanent record of OT&E events, and audit trail of OT&E data, test results, conclusions, and recommendations. This information is used to prepare for Milestone C and supports a recommendation of whether the design and performance of the system in development justifies proceeding into LRIP.

T&E Contributions Prior to Full Rate Production Decision Review

The development agency transitions the final design to LRIP while fixing and verifying any technical problems discovered during the final testing of the EDM in its intended environment. The maturity of the hardware and software configurations and logistics support system available from LRIP are assessed when the development agency considers certifying the system's readiness for Initial Operational Test and Evaluation (IOT&E).

IOT&E is conducted prior to the production decision at FRPDR to:

- 1) Estimate the operational effectiveness and suitability of the system;
- 2) Identify potential operational deficiencies;
- 3) Evaluate changes in production configuration;
- 4) Provide information for developing and refining logistics support requirements for the system and training, tactics, techniques, and doctrine;
- 5) Provide information to refine Operations and Support (O&S) cost estimates and identify system characteristics or deficiencies that can significantly impact O&S costs;
- 6) Determine whether the technical publications and support equipment are adequate in the operational environment.

Before the certification of readiness for IOT&E, the developer should have obtained the Joint Interoperability Test Command's (JTIC) certification of interoperability for the system components. In parallel with IOT&E, Live Fire Test and Evaluation (LFT&E) may be used to evaluate vulnerability or lethality of a weapon system as appropriate and as required by public law. The PM's briefing and the Beyond Low Rate Initial Production (BLRIP) report address the risks of proceeding into Full Rate Production (FRP).

T&E Contributions after the Full Rate Production Decision Review

After the FRPDR, when the FRP decision is normally made, T&E activities continue to provide important insights. Tests described in the TEMP but not conducted during earlier phases are completed. The residual DT&E may include extreme weather testing and testing corrected deficiencies. System elements are integrated into the final operational configuration, and development testing is completed when all system performance requirements are met. During FRP, government representatives usually monitor or conduct the Production Acceptance Test and Evaluation (PAT&E). Each system is verified by PAT&E for compliance with the requirements and specifications of the contract.

Post-production testing requirements may result from an acquisition strategy calling for increment changes or the application of Preplanned Product Improvements (P³Is). This will allow parallel development of high-risk technology and modular insertion of system upgrades into production equipment. Technology breakthroughs and significant

threat changes may require system modifications. The development of the modifications will require developmental testing; if system performance is significantly changed, some level of operational testing may be appropriate.

OT&E activities continue after the FRP decision in the form of Follow-on Operational Test and Evaluation (FOT&E). The initial phase of FOT&E may be conducted by either the OT&E agency or user commands, depending on Service directives. This verifies the operational effectiveness and suitability of the production system, determines if deficiencies identified during IOT&E have been corrected, and evaluates areas not tested during IOT&E due to system limitations. Additional FOT&E may be conducted over the life of the system to refine doctrine, tactics, techniques, and training programs, and to evaluate future increments, modifications, and upgrades.

The OT&E agency prepares an OA report at the conclusion of each FOT&E. This report records test results, describes the evaluation accomplished to satisfy critical issues and objectives established for FOT&E, and documents its assessment of deficiencies resolved after SDD. Deficiencies that are not corrected are recorded.

A final report on FOT&E may also be prepared by the using command test team, emphasizing the operational utility of the system when operated, maintained, and supported by operational personnel using the concepts specified for the system. Specific attention is devoted to the following:

- 1) The degree to which the system accomplishes its missions when employed by operational personnel in a realistic scenario with the appropriate organization, doctrine, threat (including countermeasures and nuclear threats), environment, and using tactics and techniques developed during earlier FOT&E;
- 2) The degree to which the system can be placed in operational field use, with specific evaluations of availability, compatibility, transportability, interoperability, reliability, wartime usage rates, maintainability, safety, human factors, manpower supportability, logistics supportability, and training requirements;
- 3) The conditions under which the system was tested including the natural weather and climatic conditions, terrain effects, battlefield disturbances, and enemy threat conditions;
- 4) The ability of the system to perform its required functions for the duration of a specified mission profile;
- 5) System weaknesses such as the vulnerability of the system to exploitation by countermeasures techniques and the practicality and probability of an adversary exploiting the susceptibility of a system in combat.

A specific evaluation of the personnel and logistics changes needed for the effective integration of the system into the user's inventory is also made. These assessments provide essential input for the later acquisition phases of the system development cycle.

Summary

“Risk management,” according to Transition from Development to Production, “is the means by which the program areas of vulnerability and concern are identified and managed.”⁵ T&E is the discipline that helps to illuminate those areas of vulnerability. The importance of T&E in the acquisition process is summarized well in a July 2000 General Accounting Office (GAO) Report NSIAD-00-199, *Best Practices: A More Constructive Test Approach is Key to Better Weapon System Outcomes*.⁶ The summary serves to underscore the importance of the T&E process as a whole:

- Problems found late in development signal weaknesses in testing and evaluation;
- Early testing to validate product knowledge is a best practice;
- Different incentives make testing a more constructive factor in commercial programs than in weapon system programs.

“To lessen the dependence on testing late in development and to foster a more constructive relationship between program managers and testers, GAO recommends that the Secretary of Defense instruct acquisition managers to structure test plans around the attainment of increasing levels of product maturity, orchestrate the right mix of tools to validate these maturity levels, and build and resource acquisition strategies around this approach. GAO also recommends that validation of lower levels of product maturity not be deferred to the third level. Finally, GAO recommends that the Secretary require that weapon systems demonstrate a specified level of product maturity before major programmatic approvals.”⁷

Endnotes

1. DoDD 5000.1, *The Defense Acquisition System*, May 12, 2003, pg. 8.
2. BDM Corporation, *Functional Description of the Acquisition Test and Evaluation Process*, July 8, 1983.
3. Defense Science Board Task Force Report, *Solving the Risk Equation in Transitioning from Development to Production*, May 25, 1983 (later published as DoD Manual 4245.7).
4. DoD 4245.7-M, *Transition from Development to Production*, September 1985.
5. *Ibid.*
6. GAO/NSIAD-00-199, *Best Practices: A More Constructive Test Approach is Key to Better Weapon System Outcomes*, July 2000, p. 11.
7. *Ibid.*